

THURSDAY, JANUARY 4, 1877

## THE FARADAY LECTURE FOR 1875

*The Life Work of Liebig in Experimental and Philosophic Chemistry.* By A. W. Hofmann, F.R.S., &c.  
Delivered before the Chemical Society of London.  
(London: Macmillan and Co.)

IN this volume we have given us a sketch of the labours of Liebig in the domain of Pure and Applied Chemistry, and also an account of his manifold investigations in the direction of its Application to Agriculture and Physiology.

Prof. Hofmann has been induced to take the works of this great chemist as the theme for the Faraday lecture, not only from its being a subject in itself rich in most interesting matter, but, that from Liebig's studies on the relation and mutual bearing of the facts discussed by him, he was led to the conception of general laws elucidating chemical phenomena; thus standing beside Faraday as a fit representative of our century to future generations. Notwithstanding the great reputation Liebig now possesses, Prof. Hofmann seems to think that at the present time, we being almost contemporaneous with this great chemist, are not in a position to give to his works such appreciation as will be yielded them in the future; on this point Prof. Hofmann says:—

"As those who wander in a mountain chain cannot appreciate the sky-reaching grandeur of its lofty peaks as well as those who remotely from the plains beneath contemplate its snow-crowned summits, so we, the contemporaries of Faraday and Liebig cannot perceive the full dignity of their commanding forms—the philosophic pinnacles of this century—as they will hereafter appear to distant generations of posterity. In these days Faraday and Liebig will be looked up to with such reverence as it is ours to offer to the mighty spirits of the past—to such giant figures as those of Galileo, Kepler, Newton, and Lavoisier. And as that bright constellation shines on us from the misty darkness of the past, so will the names of Faraday and Liebig—stars of co-equal lustre—throw forward their bright beams on our successors through the far-reaching vista of ages yet to come."

Although expressing himself at the outset embarrassed by the richness of the subject, and consequently the difficulty of making any proper classification or selection of the many interesting investigations and discoveries to be discussed, Prof. Hofmann must be congratulated on the very successful result which has crowned his endeavours.

Commencing with a short review of the general work of Liebig with regard to the elaboration of apparatus and analytical methods for chemical research, Prof. Hofmann proceeds to speak of the great power Liebig had in imparting knowledge to others, and his influence over the mind of his pupils. He next draws attention to the resemblance between the labours of Liebig and Faraday in abstract science, and the abundant results they have produced in their applications to the useful arts.

In the field of agricultural chemistry, in his investigation of the laws regulating the growth of plants, we learn from Prof. Hofmann that Liebig first penetrated the doubt and uncertainty which had previously existed, establishing with certainty the relation which exists between the growing plant and soil and air in which

it lives. Standing as a monument of his most exhaustive researches on this point, we have his two works: "Chemistry in its Application to Agriculture and Physiology," and "The Natural Laws of Husbandry," this latter work constituting the first perfect treatise on the philosophy of agriculture which had appeared up to that time. To Liebig is also due the knowledge we now possess, that for proper vegetable growth the plant must be supplied through the land with those constituents which are found in its ash; and, as a sequence following from this, the fact, that should the soil become deprived of such constituents, it will be unfit for further plant growth till the proper saline ingredients are returned to it. With the knowledge acquired on such points he was naturally led to the production of artificial manures as a means for the fertilisation of land impoverished and exhausted by the crops grown upon it.

Passing from Liebig's labours in agricultural chemistry to those in the higher branch of biology, we find his discoveries producing no less perfect and important results. Although many isolated researches, as those of Chevreul, Berzelius, Gmelin, and Tiedeman, had been already conducted on certain constituents of the animal economy, still we owe to Liebig the collection of these widespread attempts into a "focus" for the elucidation of the phenomena of animal life. Of Liebig's chemico-biological work perhaps the best instances we can refer to are his "Investigations into the Origin of Animal Heat," his "Theory with regard to the Nutrition of Animals," and his "Doctrine of the Origin and Function of Fat in the Animal Economy." In the first of these inquiries he reviews the ideas of Lavoisier and Laplace, and the experiments of Dulong and Despretz, pointing out the errors of experiment the two latter investigators had fallen into, and from his own minute calculations proving the sensible heat of the animal body to be explained by the processes of combustion carried on within the organism. From his inquiries into the chemical nature of food, Liebig was led to his theory that the vegetable stands in a position intermediate between the mineral and the animal. The animal being unable to assimilate inorganic compounds, the vegetable acts as a means for transforming the mineral molecules into those of a higher order fit for the proper maintenance of the animal organism. The facts necessary for the support of his theory are to be found in the identity in composition of the nitrogenous principles, animal and vegetable, albumin, casein, and fibrin; a fact previously pointed out by Mulder, but exactly determined through analysis either by Liebig or his pupils.

In the views promulgated by Liebig that it is in the animal organism, through the transformation of starch, sugar, &c., that the chief formation of fat takes place, he was led into a long and animated controversy with Dumas and Boussingault; but in this, as in other of his discussions, experiment has decided in favour of Liebig. Although the experiments of his opponents proved the existence of fat in vegetables, it was nevertheless in quantities quite insufficient to account for the amount found in animals when fed artificially on vegetable food alone. Like his investigations in agricultural chemistry, Liebig's discoveries in the biological branch yielded their proportion of practical applications, and from his investigations of the composition and nutrition of the animal body arose

the methods now used for the preparation of condensed food and for its preservation without decomposition.

On examining the purely scientific work of Liebig brought before our notice by Prof. Hofmann, the reader is at once struck by the varied nature of the researches. In his experiments on the cyanogen group, resulting from his examination of the fulminates, we are led back to some of the earliest stages of Liebig's scientific career. In this investigation, published at the age of nineteen and detailing experiments extending over two years, we have accurate proof given us of the very early age at which he had recognised the natural tendency of his mind. His experiments proving the fulminates to be isomeric with the cyanates brought him in contact with Wöhler, already working on the same ground, this friendship being soon destined to exercise a most important influence upon organic chemistry.

Liebig's investigations upon alcohol and its derivatives are interesting, not only from the fact that it was from his earlier experiments on this body proceeded the discovery of chloral and chloroform, but also that in his endeavours to elucidate the constitution of alcohol he was led into a long protracted discussion with Dumas and Boullay, a discussion resulting in the victory of Liebig. It would be impossible here to give a detailed notice of the remaining investigations of Liebig touched on by Prof. Hofmann in his discourse; it will be sufficient for us to mention Liebig's researches on the group of benzoic compounds, his discoveries in uric acid and its derivatives, executed in conjunction with Wöhler, and his elaborate work on the constitution of the organic acids.

Many as Liebig's experimental researches were he still found time for literary labour. It would be almost sufficient to mention the work founded by him, in conjunction with his friends, Wöhler and Hermann Kopp, as early as 1832, a work then and now known as "Liebig's Annalen," a most invaluable collection of recent experimental discovery. Of his other larger works two more may be mentioned, his "Dictionary of Pure and Applied Chemistry," begun conjointly with Poggendorff and Wöhler, and his "Handbook of Organic Chemistry," a treatise translated into French and English by Gerhardt and Gregory respectively.

Examining the whole "Life Work of Liebig" as put before us in this admirable discourse of Prof. Hofmann, the reader must be at once struck with the enormous amount of work which it is almost impossible to believe could have been accomplished by one man during a lifetime. The number of his papers published in the records of the Royal Society alone is, we are told by Prof. Hofmann, 317, of which 283 are by Liebig himself, the remainder published in conjunction with other chemists. It is worthy of remark, however, that from the number and ability of the pupils he drew around him, Liebig was able to trust certain of his researches to their care, invariably, however, giving his assistants all credit for any ideas or discoveries of their own.

If Liebig was followed, originally by his pupils it was because he possessed the rare gift of inspiring them not only with admiration but with love. With the spirit which was equally characteristic of Faraday's genius, Liebig endeavoured to lead his followers beyond mere single spheres of thought to the conception of laws regu-

lating wide ranges of phenomena, tending in their results to the material welfare of mankind.

We feel sure that this interesting account of the work of one so distinguished and widely known as Justus Liebig, will be read with great pleasure not only by chemists but by all who are interested in the progress of natural science.

JOHN M. THOMSON

#### HUNTING-GROUNDS OF THE GREAT WEST

*The Hunting-Grounds of the Great West, a Description of the Plains, Game, and Indians of the Great North-American Desert.* By Richard Irving Dodge, Lieut.-Col. U.S.A. With an Introduction by William Blackmore. (London: Chatto and Windus.)

MR. WILLIAM BLACKMORE, well known to anthropologists in connection with the Blackmore Museum at Salisbury, hunted buffalo on the great plains of the Far West with Col. Dodge. The American colonel's camp-fire stories seemed to his English companion well worth preserving, and thus the present volume came to be written, and dedicated to Mr. Blackmore, who has prefaced it with an introduction on the Indian tribes of North America and the causes of their extinction. No doubt Mr. Blackmore was right in encouraging his friend to write his book, which contains much curious information not got up out of other books, but drawn direct from life in the Indian country, and told well in barrack-room fashion. The bold picturesque illustrations by Grisct suit the contents well, and the volume in its red and gold binding might have been recommended as a gift-book, had the author had the discretion and good taste to exclude certain stories as to the relations of the sexes among Indian tribes, as well as several pages of revolting details respecting the fate of those who fall as captives into the hands of such tribes as the Comanches, which ought not to have found a place in it.

In pointing out that these contents must in great measure remove the book from popular circulation, we do not say that they should not have been printed somewhere, though a smart *ad captandum* volume was not the proper place. In fact they form part of a general description of Indian society, which students of the development of law and morals may read with considerable advantage. The necessary growth of some rule of female propriety in societies where the women are the absolute chattels of the men, is illustrated with remarkable clearness among the Cheyennes (see p. 301, &c.), and all the more plainly by contrast with the habits of their husbands, who, being no one's property, own no social restraint whatever. Again, however brutal the individuals of any tribe may be, there must be a social contract observed or the whole society would collapse. This also is well shown among the Cheyennes, by the fact that women obtain absolute protection by a merely symbolic form, which, if any man failed to respect, he would certainly be killed (p. 303). Again, the existing marriage law of the Cheyennes (p. 300) furnishes an instructive commentary on the story of King Gunther's marriage with Brynhild in the Nibelungen Lied, which is possibly a relic of Germanic custom in remote barbaric times. These are a few among many points in which modern savage society throws light on the